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(71) Applicant: AMPHENOL CORPORATION [US/US]; 358 Hall Avenue, P.O. Box 384, Wallingford, CT 06492 (US).

(72) Inventors: SPIEWAK, John, Chester ; 6424 Pershing, Berwyn, IL 60402 (US). MARGOLIN, Mark ; 6611 Lawndale, Lincolnwood, IL 60645 (US). GROIS, Igor ; 7136 N. Keystone, Lincolnwood, IL 60645 (US).

(74) Agents: KENNEY, J., Ernest et al.; Bacon & Thomas, 625 Slaters Lane - Fourth Floor, Alexandria, VA 22314 (US).

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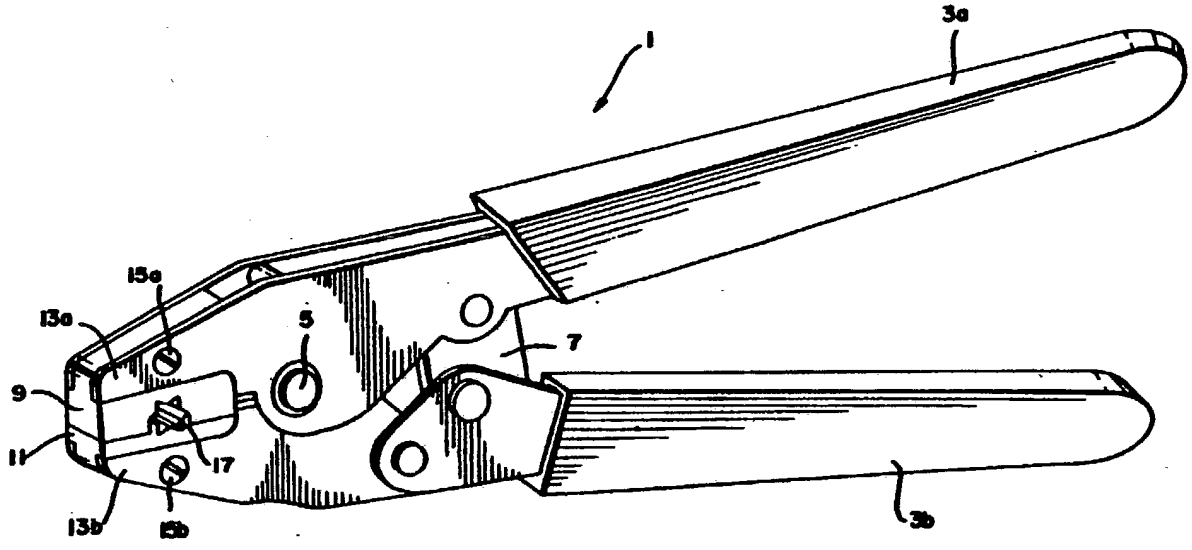
(54) Title: CRIMP TOOL AND DIES THEREFOR FOR USE IN ATTACHING FIBER OPTIC CABLE TO FIBER OPTIC CONNECTORS



(57) Abstract

Crimping tool (1) and improved dies (9, 11) for use in securing fiber optic connectors to cables. The dies include a crimping region (18a, 18b) which when the two dies are brought together, define a star shape space having six or eight points. The longitudinal passage (27) in one of the dies leads into the crimping region and serves to prevent material creep of the material being crimped when the two dies are brought into crimping engagement.

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DESCRIPTION

CRIMP TOOL AND DIES THEREFOR FOR USE IN ATTACHING FIBER OPTIC CABLE TO FIBER OPTIC CONNECTORS

BACKGROUND OF THE INVENTION

This invention relates to a crimping tool for use in securing fiber optic cables to fiber optic connectors in a secure manner wherein little or no stresses are placed on the terminated fiber of the cable. The invention also relates to an improvement in a fiber optic connector assembly having had a fiber optic cable secured thereto by means of the crimp tool with improved dies of the invention.

Tyically, fiber optic connectors are designed to secure a fiber optic cable, for termination purposes, at least at two different portions thereof. More specifically, fiber optic cables are generally a concentric arrangement, described from the outside in, comprised of an outer protective sheath covering a layer of strength fibers which cover the fiber extending through the center of the cable. In addition, this fiber is itself often covered by what is known as a buffer layer, typically silicone or some other soft material as is well known to those of ordinary skill in the art.

The termination of the fiber optic cable generally involves seizing the fiber directly within the body of a connector in a manner such that the end of the fiber is held within a mating ferrule of the connector with the end thereof. In addition, in order to prevent stresses from being applied to the held fiber, and to ensure a secure fastening to and within the connector, the cable is also secured to the non-mating end of the connector at the outer sheath and strength layer thereof.

In one prior art connector, in order to secure the cable to the connector, a sleeve is received within the cable in a manner surrounding the buffer covered fiber,

and such that the strength layer and the outer sheath concentrically overlie the sleeve. A crimp extension of the back end of the connector coextends with the sleeve in a manner such that the strength layer and outer sheath are received between the sleeve and the crimp extension. The cable is then secured by crimping the crimp extension. Such an arrangement is disclosed, for example, in copending U.S. application Serial No. 766,743 filed August 16, 1985 which names inventors in common with this application, and which disclosure is specifically incorporated by reference herein.

In the past, in order to effect the crimping operation, standard crimp tools and dies of the type employed with conventional electrical cables and electrical connectors have been employed. The crimp surfaces of such dies generally define a hexagonal surface. However, it has been found that often when employed with fiber optic cables and connectors, the crimp made by such a die is non-uniform and fails to securely fix the cable to the connector. More often than not, the fiber itself is displaced from a central position causing alignment difficulties when siezed within the connector.

SUMMARY OF THE INVENTION

In accordance with the invention there is provided an improved crimping tool with an improved die structure which obviates the above-discussed disadvantages. More specifically, securing of fiber optic cables is difficult because the depth of the required crimp must typically be much greater than the crimping required for standard electrical cable. This is because the depth of the portion of the cable being secured, i.e., the outer sheath and strength layer, is significantly greater than in the case with electrical cables which have only a thin insulating coating or covering immediately adjacent the wire conductors thereof. Moreover, in electrical cables the conductors themselves may be subjected to

crimping. However, this is not possible in the case of a fiber of a fiber optic cable since the fiber would become damaged and inoperative. Accordingly, it is essential to provide a much deeper crimp when attaching fiber optic cables to connectors, which crimp must be uniform, provide sufficient holding power, centrally position the fiber and must not stress the portion being crimped beyond its breaking point.

The invention comprises an improvement in a crimp tool used for crimping with fiber optic connectors of the type wherein removable crimp dies are provided which determine the shape and configuration of the resulting crimp when the tool is used. The improvement resides in the configuration of the dies which comprise two parts which when the two parts are brought together define a star shape, having at least six points, within the inner clamping surface thereof.

In a more specific aspect the star defined has 6 or 8 points with the angles at the transitions between points and at the point ends falling within predetermined values sufficient to ensure a uniform and secure crimp when employed to attach fiber optic cables to fiber optic connectors.

Further, in a still more specific aspect, the dies are employed in a crimp tool of the type having two jaws which come together by pivoting about an axis to which they are attached. The pivoting is caused by exerting a force on two handles extending from the axis away from the jaws. In this type of tool the improvement in the dies further comprises, preferably in the top die, a vertically extending channel which guides the bottom die in an aligned manner into engagement with the top half. This channel ensures that the final crimping movements of the dies are substantially linear in nature. Moreover, as crimping commences, material creep of the object being crimped is avoided since the channel serves to confine all material within the dies surfaces.

In another aspect the invention resides in the above-described dies themselves.

BRIEF DESCRIPTION OF THE DRAWINGS

Having briefly described the invention, the same will become better understood from the following detailed discussion thereof, made with reference to the attached drawings wherein:

Figure 1 is a perspective view of an assembled crimp tool for use with the crimp dies in accordance with the invention, and shown with the crimp dies mounted therein;

Figure 2 is a view as in Figure 1, showing the dies in accordance with the invention disassembled from the tool;

Figure 3 is a side view, in enlarged form, showing the crimp dies, and the various features thereof, in accordance with the invention;

Figure 4 is a partial front cross-sectional view of the dies in accordance with the invention; and

Figure 5 is a schematic view from the side, illustrating the two dies brought together to define the interior configuration defining a six-pointed star illustrating the specific features of the preferred embodiment invention.

DETAILED DISCUSSION OF THE INVENTION

In Figure 1 there is shown a crimp tool 1 assembled with the improved crimp dies 9 and 11 in accordance with the invention. Generally speaking, the tool 1 includes two handles 3a, 3b which cause two jaws 13a, 13b to pivot about a pivot axis 5 to clamp the two dies 9,11 together onto the back of a fiber optic connector in a conventional manner to effect crimping thereof to secure a fiber optic cable thereto.

As more clearly shown in Figure 2, the dies 9,11 are held on the jaws 13a, 13b by screws 15a and 15b. The operation of the tool is such that a ratchet

mechanism 7, conventional in nature and not shown in detail, serves to permit the tool 1 to be clamped without permitting reverse motion until the full range of movement into a clamping position has been followed, at which time the conventional ratchet mechanism 7 will release and permit the tool to be opened again. Figure 1 shows the dies 9, 11 in accordance with the invention brought together such that the crimping region is constructed in a manner to define a star shape cavity 17. The star shape cavity 17 is made up by two half star shape configured die regions 18a and 18b as shown in Figure 2.

In Figure 3 the dies 9, 11 in accordance with the invention are more clearly shown. More specifically, an upper die 9 is shown which includes star shape region 18a from which extends a passage 27 of a predetermined depth B. This passage 27 corresponds in depth to the height A of crimp region 18b of lower die 11. Accordingly, when the dies 9, 11 are brought together, the engagement of die region 18b as shown by a raised portion 21 terminating at edge 23 is received within passage 27 so that upon the end of clamping movement, which at this point is almost substantially vertical, as the material being crimped is engaged by the walls of the dies 9, 11 at the crimping regions thereof, the passage 27 prevents any material creep outside of the die crimp region 17 ensuring a substantially uniform crimp configured in accordance with the regions 18a and 18b. The width of the lower die crimp region 18b is of a predetermined width E which is slightly smaller than the width of passage 27 which is of predetermined width D. In order to account for any slight variations in tolerances, a cutout portion, more clearly shown as 25 at an angle α , which is typically of about 45 degrees, is provided to ensure centering of the lower crimp region 18b with the upper crimp region 18a. The angle α provides for a tolerance region of predetermined width C, the dimensions of all of these

portions being determined conventionally in accordance with the size of the crimp dies employed for crimping predetermined sized connectors.

As further shown in Figure 4, the dies 9 and 11 include the star shape crimp region 17 in the center thereof, but towards the outer edges there is a non-crimp configured region of predetermined depth G and A which facilitates centering on the connector and ensures that portions of the connector which are not to be crimped are not inadvertently crimped by use of the tool 1.

The novel configuration of the dies in accordance with the invention is more clearly shown in Figure 5 which is a partial view showing various features of the invention with the two dies brought together. As can be seen from said figure, the crimp region 17 is shaped to define a six-pointed star in a preferred embodiment. In this regard, it is noted that although a six-pointed star is shown, an eight-pointed star configuration can also be employed depending on the desired crimping effect and the size of the connector upon which it is being employed. Anything less than six points or greater than eight points would result in an unsatisfactory crimp inasmuch as greater than eight points approaches a circular configuration and does not provide sufficient depth of crimping in connection with fiber optic cable, and anything less than six points provides for too deep a crimp possibly tearing the material being crimped, or if configured not sufficiently deep, resulting in an inadequate crimp.

As shown in Figure 5, optimum angles are shown wherein the angle defined by the center of the crimp region and extending through the points of two adjacent stars, shown as θ is 60 degrees. On the other hand, limiting this angle θ to 60 degrees is not necessary and the angle θ can fall within a range of about 40 degrees to 70 degrees. The other angles illustrated of course will vary in accordance with the variation in the

above-variation in angle θ. As shown also in Figure 5, preferably the angle made up by each star point on the inside thereof is preferably a 90 degree angle θ θ with the half angle β being a 45 degree angle. The corresponding half angle ζ as defined from the center of the star through a point of the star and the transition zone between two points of the stars is, in the case when θ equals 60 degrees, equal to about 30 degrees.

As noted previously, all these angles will vary in accordance with the variation in the angle θ. It is noted however in this regard, that the angle θ can be as large as 150 degrees although as previously indicated, 90 degrees is an optimum.

In another aspect of the invention, it is noted that it is essential that the number of stars points be kept at an even number to provide a symmetrical crimp which is essential in fiber optic cables. Thus, a five or seven pointed star is not desireable.

With respect to the materials employed to make up the die, typically steel, brass or bronze can be employed. These materials will be of a hardness range selected in accordance to the specific crimp sleeve with which it is to be employed. The selection of the hardness range and materials is conventional and well known to those of ordinary skill in the art.

Having described the invention, the same is broadly defined in the appended claims in a manner intended to be non-limitative.

WHAT IS CLAIMED IS:

1. In a crimp tool of the type comprising two jaw members actuatable by two handles, the jaw members being adapted for having two crimp dies respectively secured therein, and the crimp dies secured within the jaw member having a crimping region of predetermined configuration, the improvement wherein the crimp regions of the dies are configured such that when the jaw members are brought together for crimping, the crimp regions define a star shaped space having one of six or eight points.

2. A crimp member in accordance with claim 1 wherein said crimp regions are configured to define a star having six points.

3. A crimp tool in accordance with claim 2 wherein said star shape of the crimp regions of the die members is configured such that an angle θ defined by lines extending from the center of the star through two adjacent points of the star is equal to about 40-70 degrees.

4. A crimp tool as in claim 3 wherein said angle θ is equal to about 60 degrees.

5. A crimp tool as in claim 1 wherein one of said dies further comprises a longitudinally extending passage of predetermined depth leading into the crimp region thereof.

6. A pair of dies for use in a fiber optic connector crimp tool, said dies having crimp regions respectively which regions are configured such that when the dies are brought together for crimping, the crimp regions define a star shaped space having one of six or eight points.

7. A pair of dies as in claim 6 wherein said crimp regions are configured to define a star having six points.

8. A pair of dies as in claim 7 wherein said star shape of the crimp regions of the die members is configured such that an angle θ defined by lines

extending from the center of the star through two adjacent points of the star is equal to about 40-70 degrees.

9. A pair of dies as in claim 8 wherein said angle θ is equal to about 60 degrees.

10. A pair of dies as in claim 6 wherein one of said dies further comprises a longitudinally extending passage of predetermined depth leading into the crimp region thereof.

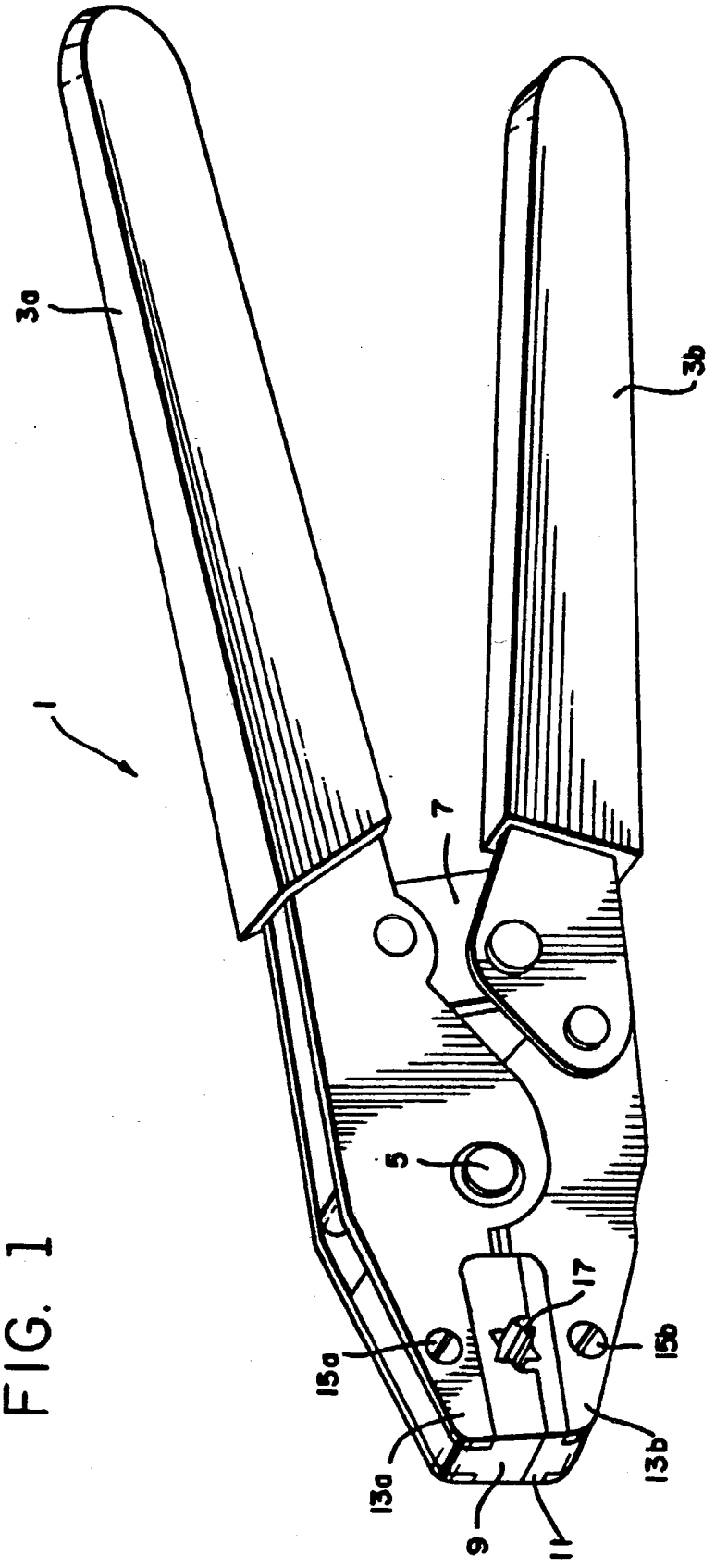


FIG. 1

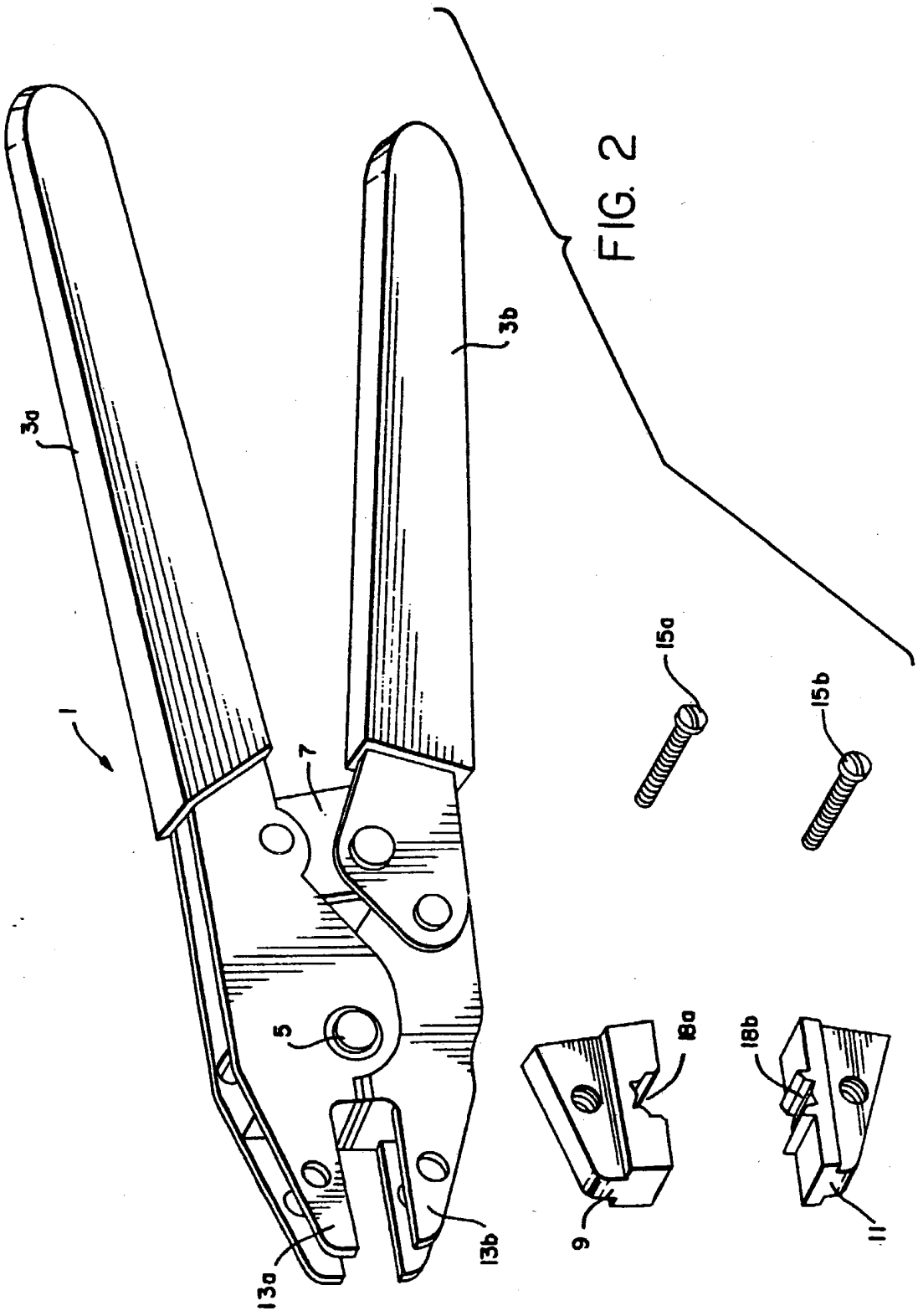


FIG. 2

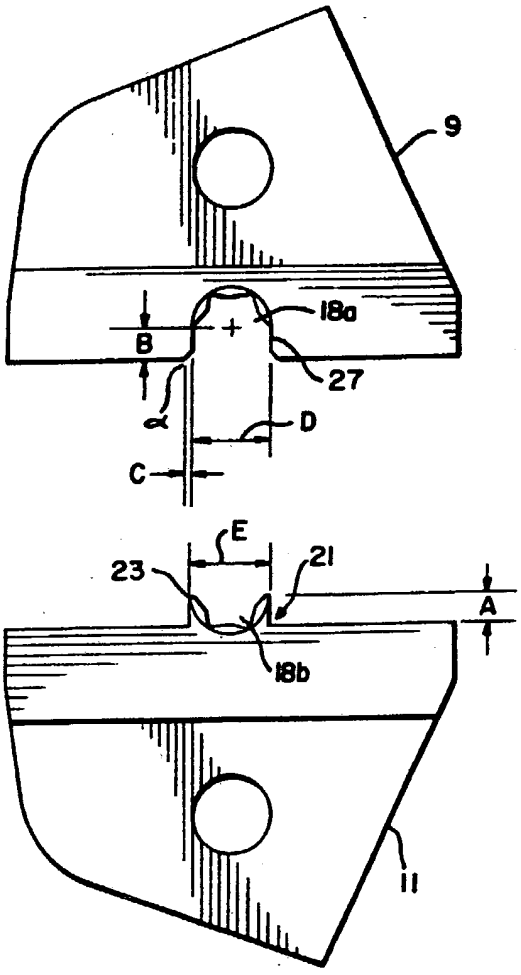
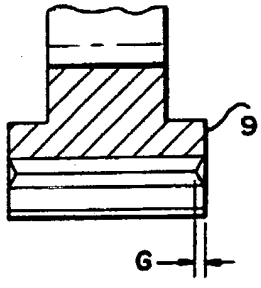


FIG. 3



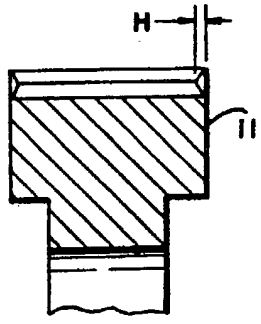


FIG. 4

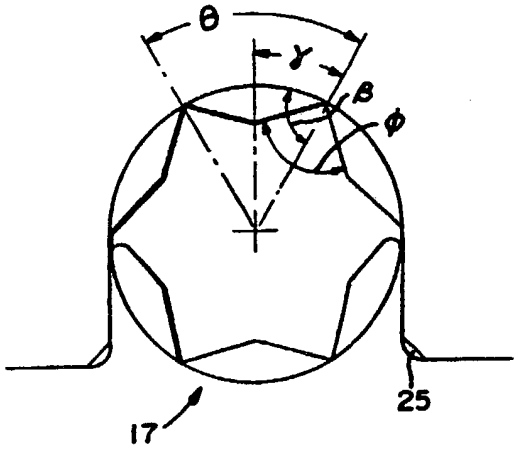


FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No PCT/US87/01638

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(4): B21D 9/08, B25B 7/02, H01R 43/04, B23P 19/00
U.S. Cl. 81/418, 421, 426; 72/ 410; 29/ 862, 751, 282

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	72/410, 409; 29/862, 751, 753, 282, 631; 81/418, 421, 422, 423, 426, 426.5

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y,P	US, A, 4,654,478 (Ishihara et al) 31 March 1987. See entire document.	1
X / Y, P	US, A, 4,067,224 (Birks) 10 January 1987. See entire document.	6,8 / 1-4,7,9
Y	US, A, 3,487,524 (Filia)06 January 1970. See entire document.	1-4,7,9
A	US, A, 3,154,981 (McDurmont)03 November 1964. See entire document.	1
X	US, A, 1,085,461 (Michaelis) 27 January 1914. See entire document.	1-10

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
17 December 1987	14 JAN 1988
International Searching Authority [1]	Signature of Authorized Officer [20]
ISA/US	David B. Jones

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